Low Power Broadcasting FAQ (Frequently Asked Questions)

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[1] What equipment do I need to start a station?

You will need audio sources (tape players, CD players, microphones, etc.), an audio mixer, a transmitter, a coaxial cable (usually RG-8 or RG-58/U) to carry the signal from your transmitter to your antenna, and an antenna.

When you are selecting audio equipment, try to get items that have metal cases (not plastic or wood) and three-prong grounded electrical plugs. This will reduce your chances of having problems with radio energy from your transmitter getting into your audio gear and causing interference.

The most important item for a low power broadcaster is the _raison _ d'etre_, the reason for existing. You won't have a high power signal, and you won't have billboards and TV commercials announcing the existence of your station, so listeners will have to put some effort into finding and receiving your signal. They probably won't make the effort unless you are offering something unique and interesting.

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[2] Is low power broadcasting legal?

This depends on what country you are in. Here in the United States, legal unlicensed broadcasting is limited to microscopic power levels. For example, the limit for unlicensed FM transmissions is 250 microvolts per meter, measured 3 meters from the transmitting antenna; at this power level, stereo reception with a good signal to noise ratio is only possible within a 100 foot radius, and an average car radio can barely detect the signal at a distance of 200 meters. On the AM band, the limit is 0.1 watt and an antenna system no more than 3 meters long.

Violators who get caught are usually given a monetary fine, and sometimes their equipment is confiscated. The situation varies from country to country.

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[3] How much power do I need?

There is no simple answer to this question. For starters, it depends on whether you are broadcasting on the AM (medium wave) band, the FM band, the international shortwave bands, or TV. In order to reduce interference to other radio services, it is always a good idea to use the lowest amount of power that will serve your target audience.

On FM and TV frequencies, raising your antenna height and improving the gain of your antenna system is generally a better way to increase your range than using a more powerful transmitter. If an FM or TV broadcast antenna is only 12 feet (4 meters) above the ground, for example if it's in the attic of a one-story building, then its range will always be limited to a few kilometers and the signal will always be plagued by multipath interference, even if you pump a million watts into it.

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[4] Where can I get a transmitter?

Below is a brief list of companies selling low power transmitter kits. Please send me information about any companies not listed, so that I can include them in future versions of this list.

Note to newcomers: to assemble these kits, you must be able to solder components onto a circuit board, and it helps if you know the difference between a resistor and a capacitor. If you haven't reached this stage of electronic know-how yet, consider buying some of the educational kits available from C&S Sales, 1245 Rosewood, Deerfield IL 60015, telephone 800-292-7711. Their electronic components course (item #ECK-10, $14.95) might be especially helpful to newbies.

When assembling radio circuit kits, I prefer to use narrow-diameter silver-bearing solder (Radio Shack #64-013) and a 15 watt soldering iron. You will need a more powerful soldering tool for making antennas out of large-diameter wire, soldering really large connectors to a printed circuit board, etc., but the 15 watt iron works fine for assembling most kits and reduces the chances of over-heating transistors and other heat-sensitive components.

a word about the BA1404 chip:

Many of the FM kits listed below use Rohm's BA1404 integrated circuit, which is esentially an FM transmitter in a single 18-pin chip. The BA1404 has some limitations in sound quality. The separation between the left and right channels and the overall audio distortion are not up to "broadcast standards." To get a clear idea of how bad it is, obtain a studio reference CD (a.k.a. audio system test CD) that has a "sweep" on it -- a sweep is a tone that steadily rises

in pitch from very low to very high -- and play the sweep through any BA1404-based transmitter, while listening on a high-quality receiver. Blecccch!

------ sources of AM, FM, and TV transmitters: ------

DC Electronics
P O Box 3203
Scottsdale AZ 85271
phone 800-423-0070

The Improved Stereocaster is an FM stereo transmitter based on the BA1404 chip with a few milliwatts of output power ($29.95 plus $3.50 S&H). It has a smooth fine-tuning control which makes it easy to get on the exact frequency you want, and a voltage regulator for the BA1404 which improves stability.

Compared to Ramsey's FM-10A, the Stereocaster doesn't drift as much, and I think the audio quality is slightly better; however the assembly instructions are not as clear as Ramsey's, the PC board layout is not as elegant, and Ramsey's circuit puts out a little more power.

Free Radio Berkeley
1442 A Walnut St., #406
Berkeley, CA 94709
phone 510-464-3041

Items listed in their ads include a 5 watt mono FM transmitter kit ($55 plus shipping), a 1/2 to 1 watt stereo FM transmitter kit ($50), an FM transmitter with phase locked loop (PLL) frequency control ($95), plus kits for output filters, dummy loads, RF amplifiers, and antennas.

FRB is spear-heading an organized challenge to the FCC’s regulations and is trying to foster a low power broadcasting movement. Contact them for more info. (Internet: frbspd@crl.com)

Some people have posted messages in alt.radio.pirate indicating that FRB sometimes takes several weeks or months to respond to orders.

North Country Radio
PO Box 53, Wykagyl Station
New Rochelle NY 10804-0053
phone 914-235-6611
(send $1 for catalog)

Many TV-related items: a 50 milliwatt UHF transmitter with crystal controlled frequency ($78); a "video pallete" to create special effects; a switcher that does

cross-fades and wipes; and upconverters that will take channel 3 video from a VCR and shift its frequency up to any UHF channel 25 thru 70. For licensed radio amateurs, they have a line of more powerful UHF TV transmitters.

With a 100-foot range and a price of $62.50, their FM stereo transmitter is not exactly competitive, but it is interesting from a technical point of view. Their stereo infrared transmitter and receiver could be used to build a difficult-to-trace studio-to-transmitter link.

Panaxis Productions
P O Box 130
Paradise CA 95967-0130
(send $1 for catalog, or $2 if you're in a hurry)

This company offers many interesting books and kits. The REB-1 kit is a 100 milliwatt transmitter for the upper end of the AM band ($34.95 plus shipping). The FMO kit ($75) is a high fidelity stereo FM transmitter kit with 2 to 20 milliwatts of output power. The FME-500, a half-watt mono FM transmitter with excellent technical specs, can be combined with their stereo generator to build a high-quality low power station (> $200 for the two kits). Panaxis kits might not be suitable for absolute beginners; you should have some experience in circuit assembly before you tackle these.

Progressive Concepts
1434 N. Mills Ave.
Claremont CA 91711

RF amplifiers, FM transmitters and stereo generators, components for RF circuits and more.

Ramsey Electronics
793 Canning Pkwy
Victor NY 14564
phone 716-924-4560

Ramsey kits have well-written instruction manuals, and most of the circuit boards have lots of wide-open space which makes modifications easy. The company also has a good reputation for service. On the negative side, they only offer plastic cases for their broadcasting kits (transmitter circuits generally perform better in metal cases).

The FM-10A is an FM stereo transmitter kit ($34.95 plus shipping) with a few milliwatts of output power; it is based on the BA1404 integrated circuit. The

company has just introduced the FM-25 kit, which has PLL tuning for greater frequency stability; the cost is about $129. Unfortunately, the audio section of the FM-25 is identical to the FM-10A; it uses a BA1404 with inadequate RF bypassing.

Their AM transmitter kit (item #AM-1, $29.95) and their TV transmitter kit (item #TV-6, $27.95) might also be of interest; however, there is much room for improvement in the design of these two circuits. (Robert Myers of Ramsey Electronics tells me they do intend to release an improved version of the AM-1 kit at some point in the future.)

Scott Communications
6974 Larkspur Rd. RR-3
Sooke, B.C., Canada VOS-1NO
phone 604-642-2859
e-mail: kscott@pinc.com

This company offers a 3-watt mono FM transmitter which they say has good sound quality and frequency stability. Kits cost $90 plus $5 shipping; fully assembled and tested $129 + $7. Their info says, "A 1/2 wave dipole antenna and plans for a 3/4 wave antenna (3-db gain) are included with each order... We ship right to your door by air mail special delivery... Supply voltage 12-15 volts dc, supply current 0.5 amps, input sensitivity 10mV-1V, input impedance 10k-100k, freq. range 80-108Mhz, antenna feed 75ohms-RG6U, transistors 2n3553, output power 3-watts, size 3"W 6"L 2 1/2"H." They plan to offer a stereo transmitter with PLL frequency control soon.

Supercircuits
13552 Research Blvd
Austin TX 78750

This company sells a low-power TV transmitter for channels 3 thru 6 which appears to be of high quality ($49.95 plus $4.50 S & H). For licensed radio amateurs, they also sell some ham TV transmitter kits with 1 to 2 watts peak output power that can be adapted for use on UHF channels 14 thru 19, and a linear amp for boosting the output of these transmitters.

Xandi Electronics
Box 25647
Tempe AZ 85285
phone 800-336-7389 / 602-894-0992

The XFS108 kit ($41.95) is an FM stereo transmitter, probably based on

the BA1404. Their advertisements give no specifics.

In a message dated Nov 08 06:01:55 EST 1994, an22190@anon.penet.fi wrote:

>There is a company called "Spectrum Communications" in Dorchester England >that sells fm transmitters and associated gear. A transmitter tunable from >88-108Mhz (part CTX100V) with output of 0.5Watt is available for 135 pounds. >This unit is synthesised. ... The phone number is 0305-262250.

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sources of shortwave transmitters:

Shortwave pirates generally use "ham" radio gear that was designed for licensed radio amateurs. Used vacuum-tube transmitters from the 1945 to 1975 era are sold at swapmeets and hamfests; certain types are suitable for broadcasting music and speech. (The Viking Challenger is especially popular for this purpose.)

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[5] What kind of antenna should I use?

Antenna theory, design and construction is a very complex topic. If you really want to understand antennas, I recommend that you buy a copy of _The_ARRL_Antenna_Book_ (published by ARRL, 225 Main St., Newington CT 06111 USA). It is a large book and you might have to spend several weeks studying it before it all begins to make sense.

Assuming you want to get on the air in a hurry, and then build a better antenna system later on, I will describe the quickest and simplest options available. The systems described here are all less than optimum, but they will get you on the air pronto.

WARNING: There are several ways you can get killed or injured while putting up an antenna. Never get within 10 feet of a power line, and never mount an antenna where it could possibly fall onto a power line, or where a power line could fall onto the antenna. Avoid falling off of roofs and ladders. Permanent outdoor antennas must be provided with a ground rod so that lightning, if it happens to strike, will go into the ground instead of into your equipment and your body.

For FM broadcasting, try Radio Shack's omni-directional FM antenna (catalog #15-2164, price $12.99). Don't forget the 75-to-300 ohm impedance matching transformer (#15-1140 or 15-1143). (A 50-to-300 ohm transformer would be better, but you won't find those at Radio Shack.) This antenna can be mounted

on a typical TV antenna mast, or a chimney, or hidden in the attic. Best results will be obtained when it's outdoors, away from trees and other objects, and mounted several feet higher than the rooftops in your neighborhood.

In AM broadcasting, a vertical section of TV antenna mast, 10 or 20 feet long/high, makes a decent antenna. The center conductor of the coaxial cable from your transmitter is connected to the bottom of this vertical mast; the base of the mast sits on an insulator which sits on the ground. If the vertical radiator is made of several sections of antenna mast, make sure the sections are electrically connected – try screwing some self-tapping sheet metal screws into the joints. The outer conductor (shield) of the coaxial cable is connected to a set of "ground radials," which are pieces of copper wire radiating out from the base of the antenna like spokes from the hub of a wheel. (The radials are not connected to the vertical radiator.) The radials can be buried a few inches below the surface for a permanent installation. "Beware the lawnmower."

For shortwave broadcasting, a horizontal dipole works well enough. Cut two pieces of un-insulated copper wire; the length of each piece will be 234 feet divided by your frequency in MHz. Example: for 7385 kHz, each element will be (234/7.385 =) 31.7 feet long, and you will need two trees or other support structures about 63 feet apart. Solder one element to the center conductor of your coaxial feedline, and solder the other element to the outer conductor (shield) of the co-ax. (Note: the solder joints cannot bear the weight of the cable; loop the cable once over an insulator and provide some "strain relief".) Make a little loop at the free end of one element, and tie a long piece of string to that loop. Tie a small, heavy object (such as a lead fishing weight) to the other end of the string. Throw the weight up into the branches of a tree so that it goes over a branch and comes back down to earth; then hoist up that half of your antenna. Repeat the process for the other element.

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[6] How do I select a frequency?

Receivers with digital tuning will only lock onto signals that are on standard broadcast frequencies. In the US, AM stations are at 10 kHz intervals, ranging from 540, 550, 560 ... to 1600. (Some Travellers Information Stations are licensed on 530, 1610, and 1620. The channels 1610 through 1700 may soon be allocated to broadcast stations.) In some other countries, AM stations are spaced at 9 kHz intervals. FM stations are spaced at 0.2 MHz intervals, ranging from 88.1, 88.3 ... to 107.9 MHz.

Do not use an out-of-band frequency; they are allocated to other services. (For example, the frequencies just below 88 MHz are used for TV broadcasts, and the frequencies just above 108 MHz are used for aircraft communication.)

Make a survey of the band you are planning to use. Get some graph paper or notebook paper and make a list of all the channels. Listen during the day and at night, making a note of what station(s) you can hear on each channel. Use a

good receiver with digital tuning and a decent antenna, not some cheap piece of junk clock-radio or dime-store pocket radio. Repeat this band-scanning process several times during the course of a couple of weeks. (If you really want to be thorough, get a list of all the licensed stations in a 150-mile radius. You can extract this data from the _Broadcasting_Yearbook_ [a trade publication] or the FCC database [available on computer disks from several vendors]). If you know any DXers (people who make a hobby of listening to distant and unusual signals), ask them for a copy of their "log."

Now, sit down with your data and search for an appropriate channel. Don't start with any prejudices or pre-conceived notions: don't plunk your signal onto 99.9 MHz just because you think it's cute ("666" upside down) or onto 1000 kHz because you think it's an easy number to remember. Don't try to wedge your signal into the non-commercial part of the FM band (88 to 92 MHz) if there isn't an appropriate opening there.

An appropriate channel for low power broadcasting is one that is not occupied by a local station, or by an often-audible* distant station. The adjacent channels -- the next channel above and the next channel below the one you're considering -- also must not be occupied by local stations, because they will "splatter" onto your signal (and they will claim that you are splattering onto them).

There are a couple of other things you must keep in mind when selecting an FM broadcast frequency. First, if there is a TV station broadcasting on channel 6 in your area, it is unwise to operate on 88.1, 88.3, or 88.5 MHz. TV receivers have broadband tuning circuits (a TV channel is 6 MHz wide, enough spectrum to hold 30 FM stations), so broadcasts at the "low edge" of the FM band can easily interfere with reception of channel 6. In some areas where the authorities have foolishly licensed both a channel 6 and a low-edge FM station, the stations often have to go to great lengths to deal with interference complaints.

Another thing for FMers to consider is the mixing of signals that can occur in a listener's receiver. Most FM radios use an intermediate frequency of 10.7 MHz; in other words, whatever frequency you're tuned to is converted down to 10.7 MHz before the sound waves are extracted from the radio waves. As a result, a strong signal can interfere with reception of stations that are on a frequency 10.6 or 10.8 MHz above or below it.

For example, if you transmit on 92.3 MHz, some listeners who are located near your transmitter will have trouble hearing a station on 102.9 or 103.1 MHz (92.3 + 10.7 = 103.0). The interference might take the form of an "image" of your signal being heard on the other frequency, or vice versa; or a mixture of the two signals might be heard on blank spots and on top of weak signals all over the band. Any other transmitter in your immediate neighborhood, whether it's a cellular telephone system, an AM or FM broadcaster, or any other service, might interact with your transmitter in unexpected, interference-causing ways. So, do some testing with a variety of receivers (including cheap

junk) before you make a final decision on your frequency. In many major cities where the FM band is quite crowded, you will find a few conspicuous empty channels; in some cases, these channels have been kept unused (or had to be evacuated) because of interference problems caused by signals mixing together at the transmitters or in people's receivers.

*How to define "often audible" is a matter of debate; opponents of radio freedom say that _every_ channel is occupied by a distant station that some DXer might be able to hear with his 50-foot antenna tower and $1,000 radio.

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[7] Where can I get more information?

Introductory electronics textbooks are available at most bookstores and libraries. Magazines such as Electronics Now, Popular Electronics, 73, QST, Communications Quarterly, and Nuts & Volts sometimes have articles and advertisements of interest to low power broadcasters. Monitoring Times and Popular Communications carry relevant news items from time to time. The ACE, a monthly newsletter, covers shortwave pirates well and occasionally contains data useful to AM and FM broadcasters (send $2 for a sample copy to Box 11201, Shawnee Mission KS 66207).

Keep an eye on these Usenet newsgroups:
alt.radio.pirate
rec.radio.broadcasting
rec.radio.amateur.antenna

Files of some relevance are available for ftp from these sites:

site	directory	filename
crl.com	/users/ro/frbspd	(several)
dg-rtp.dg.com	/fm10	FM10-FAQ (& others)
netacsys.com	/pub/micro_radio	(several)

for WWW fans, here's a URL:ftp://netacsys.com/pub/web/mycal/mycal.html

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